Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (currently amended) A system for simulating movement of a medical device in a body cavity or lumen of a patient, comprising:

(a) a medical device comprising a first end for manipulation by a user and a portion comprising a second end insertable into a simulated body cavity or body lumen in a manikin; ~~and~~

(b) a manikin comprising an interface for receiving the portion comprising the second end and for interfacing with a simulated body cavity or lumen within the manikin, wherein the interface comprises ~~a~~ an active directional force feedback mechanism for exerting a directional force on the medical device in response to a feedback signal received by the force feedback mechanism; and

(c) a computational engine embodying physically based modeling using finite element methodology, the computational engine simulating interactions between the medical device and body cavity or lumen; and

wherein the system models interactions between the medical device and the body cavity or lumen in three-dimensions, computes forces that would arise from interactions between the medical device and body cavity or lumen and feeds back said forces to the user.

2. (currently amended) The system according to claim 1, wherein the active directional force feedback mechanism provides resistance to forward motion but enables free reverse motion in response to the feedback signal.

3. (currently amended) The system according to claim 1, wherein the active directional force feedback mechanism comprises a rolling element coupled to the portion of the

device comprising the second end and wherein an internal surface of the simulated cavity or lumen in the manikin comprises an oblique slot for receiving the rolling element.

4. (original) The system according to claim 3, wherein, in response to a feedback signal, forward movement of the second end causes the rolling element to be received by the slot, thereby causing resistance to further forward motion.

5. (original) The system according to claim 4, wherein a motor controls movement of the rolling element.

6. (original) The system according to claim 1, further comprising a tactile feedback mechanism.

7. (currently amended) The system according to claim 6, wherein the tactile feedback mechanism provides continuous ~~vibrational~~ oscillatory feedback to a user holding the medical device to simulate medical device motion induced by simulated forces neing exerted on the medical device.

8. (original) The system according to claim [8] 7, wherein continuous vibrational feedback is provided through a continuously rotating motor in communication with the portion of the device comprising the second end.

9. (original) The system according to claim 1, wherein a position of at least the second end of the medical device relative to the manikin is continuously tracked.

10. (currently amended) The system according to claim 9, wherein the medical device comprises an encoder for tracking the translation of the medical device and an encoder for tracking the rotation of the medical device.

11. (currently amended) The system according to claim 9, wherein the manikin further comprises ~~a~~ an optical tracking unit comprising a light source, a signal processing circuit, and one or more optical sensors, wherein the tracking unit is placed within the interface in optical communication with the medical device when it is inserted into the cavity or lumen.

12. (currently amended) The system according to claim 11, wherein light from the light source reflects on the medical device when inserted and wherein the reflected light is received by the one or more optical sensors.

13. (currently amended) The system according to claim 12, wherein changes in reflected light received by the one or more sensors is detected by the system, and wherein, in response to this detection, the system simulates movement of the medical device in real-time on the user display.

14. (original) The system according to claim 12, wherein two optical sensors are provided which are perpendicular to one another.

15. (currently amended) The system according to claim 12, wherein the optical tracking unit is configured in the form of a rail along which the medical device can move.

16. (original) The system according to claim 10, wherein one or more additional medical devices comprising a first end for manipulation by a user and a portion comprising a second end for insertion into the simulated body cavity or body lumen, are inserted into the interface and wherein the position of each medical device is independently monitored.

17. (original) The system according to claim 16, wherein the one or more medical devices are selected from the group consisting of a catheter, guidewire, endoscope,

laparoscope, bronchoscope, stent, coil, balloon, a balloon-inflating device, a surgical tool, a vascular occlusion device, optical probe, a drug delivery device, and combinations thereof.

18. (original) The system according to claim 1, further comprising a table for placing the manikin thereon, wherein the table comprises a processor connectable to the network.

19. (original) The system according to claim 18, wherein the system further comprises at least one first user device connectable to the network, the first user device comprising a first display interface for displaying a three-dimensional representation of a simulated body cavity or lumen of a patient.

20. (original) The system according to claim 19, wherein the first display interface further displays a three-dimensional representation of a medical device corresponding to a medical device which is interfaced with the manikin and wherein the system simulates on the display the movement of the medical device within the simulated body cavity or lumen of the manikin in real-time when a first user manipulates the medical device interfaced with the manikin.

20. (original) The system according to claim 19, further comprising a simulated scanning display for displaying a two-dimensional image of the simulated body cavity or lumen.

21. (previously presented) The system according to claim 19, further comprising a simulated scanning display for displaying a two-dimensional image of the simulated body cavity or lumen.

22. (previously presented) The system according to claim 21, wherein the simulated scanning display is part of a simulated scanning device.

23. (previously presented) The system according to claim 22, wherein the simulated scanning device is simulating an x-ray imaging system.

24. (previously presented) The system according to claim 22, wherein the simulated scanning device and scanning display are coupled to a movable C-arm within scanning distance of the manikin.

25. (previously presented) The system according to claim 1, further comprising a re-configurable control panel for performing one or more of: image acquisition selection; image display; manipulating a table on which the manikin is placed; manipulating the position of a simulated scanning device relative to the manikin; and control of one or more shutter devices for limiting a field of view of a scanning device placed within scanning distance of the manikin.

26. (previously presented) The system according to claim 1 or 20, further comprising a monitoring station, the monitoring station comprising a second user device connectable to the network and comprising a second display interface for enabling a second user to monitor the movement of the medical device within the simulated body cavity or lumen.

27. (previously presented) The system according to claim 26, wherein the second display interface of the monitoring station displays selectable options enabling the second user to select or change one or more anatomical and/or physiological parameters of the simulated body cavity or lumen, and wherein the selection causes the three-dimensional image of the simulated body cavity or lumen displayed to the first user to change to reflect the changed anatomical and/or physiological parameters.

28. (previously presented) The system according to claim 20, wherein the system is connectable to a database of patient images and/or medical data.

29. (previously presented) The system according to claim 26, wherein the system is connectable to a database of patient images and/or medical data.

30. (previously presented) The system according to claim 28, wherein the patient images comprise images of a body cavity or lumen from a patient affected by a pathology.

31. (previously presented) The system according to claim 29, wherein the patient images comprise images of a body cavity or lumen from a patient affected by a pathology.

32. (previously presented) The system according to claim 22, further comprising at least one foot-activation switch for activating or collimating the simulated scanning device, image display or table movement.

33. (previously presented) The system according to claim 28, wherein the first user display interface provides access to the database and wherein, in response to accessing, the system displays an image and/or medical data on the first user display interface.

34. (previously presented) The system according to claim 28, wherein the second user display interface provides access to the database and wherein, in response to accessing, the system displays an image and/or medical data on the second user display interface.

35. (original) The system according to claim 33, wherein the second user display interface provides access to the database and wherein, in response to accessing, the system displays an image and/or medical data on the second user display interface.

36. (original) The system according to claim 35, wherein the second user display interface provides a selectable option enabling a second user to display the image displayed on the second user display interface, on the first user's display interface.

37. (original) The system according to claim 1, wherein the device is selected from the group consisting of a catheter, guidewire, endoscope, laparoscope, bronchoscope, stent, coil, balloon, a balloon-inflating device, a surgical tool, a vascular occlusion device, optical probe, a drug delivery device, and combinations thereof.

38. cancelled.

39. cancelled.

40. cancelled.

41. cancelled.

42. cancelled.

43. cancelled.

44. (currently amended) The system according to claim 1, ~~further comprising~~ wherein the medical device comprises a syringe that simulates~~for simulating~~ fluid delivery, the syringe comprising:

a housing defining a lumen comprising an opening for delivering a fluid;

a pushing element for pushing the fluid through the opening;

a friction-producing element in communication with the pushing element; and

a motor in communication with the friction-producing element and comprising a signal-receiving element,

wherein the friction-producing element causes friction between the pushing element and a surface of the lumen of the housing upon activation by the motor in response to a signal received by the signal-receiving element, and further

wherein the opening of the syringe is connectable to a connecting piece having a first end for receiving fluid from the opening and a second end for delivering fluid to a simulated body cavity or body lumen in the manikin.

45. cancelled.

46. (currently amended) The system according to claim 1, ~~further comprising~~ wherein the medical device comprises a balloon-inflating device ~~for simulating~~ that simulates deployment of a balloon within the body cavity or lumen of the patient, the balloon-inflating device comprising:

a delivery mechanism for controlling delivery of fluid through the balloon-inflating device to the balloon;

a pressure sensor for monitoring pressure of a fluid delivered to the balloon by the balloon-inflating device;

an electrical pressure meter for reading pressure determined by the pressure sensor, the electrical pressure meter being connectable to a processor and for transmitting a signal corresponding to a pressure value to the processor.

47. (original) The system according to claim 20, wherein the system simulates deformation of the body cavity or lumen by the medical device.

48 (original) The system according to claim 20, wherein the system simulates an operation of a medical device selected from the group consisting of: a surgical procedure, inflation or deflation of a balloon, injection of a radioopaque material into the body cavity or lumen, and combinations thereof.

49. (currently amended) The system according to claim 20, wherein the system simulates the movement of the medical device within a blood vessel.

50. (original) The system according to claim 49, wherein the blood vessel is in the brain.

51. (original) The system according to claim 50, wherein the blood vessel is in the heart.

52. (currently amended) A method for simulating the movement of a medical device in the body cavity or lumen of a patient, comprising:

providing a medical device comprising a first end for manipulation by a user and a portion comprising a second end inserted into a simulated body cavity or body lumen in a manikin,

performing physically based modeling using finite element methodology to simulate interactions between the medical device and body cavity or lumen,

computing forces that would arise from interactions between the medical device and body cavity or lumen, and

wherein the simulated body cavity or lumen in the manikin comprises ~~a~~ an active directional force feedback mechanism, ~~and wherein~~ which, in response to a feedback signal, ~~the directional force feedback mechanism~~ creates resistance to forward motion of the medical device but allows free reverse motion and feeds back the computed forces to the user.

53. (currently amended) The method according to claim 52, further comprising:

providing a system comprising:

a processor in communication with the active directional force feedback mechanism, the processor connectable to the network; and

a first user device in communication with the processor, the first user device comprising a first display interface for displaying a representation of a body cavity or lumen; and for providing access to a database of three-dimensional images of body cavities and lumens from a plurality of different patients; and

enabling a user to select from the database a representation, wherein in response to the selection, the representation is displayed on the first display interface.

54. (currently amended) The method according to ~~claim 52~~ claim 53, wherein the first display interface a displays a three-dimensional representation of the medical device and wherein the system simulates the movement of the medical device within the body cavity or lumen in real-time as a first user manipulates the medical device which is interfaced with the manikin.

55. (currently amended) The method according to claim ~~52 or~~ 53 or 54, further comprising providing a monitoring station comprising a second display interface in communication with the processor and the first display interface, and wherein the second display interface provides a second user with access to the database.

56. (currently amended) The method according to ~~claim 54~~ claim 55, wherein when a second user selects a representation from the database, the representation is displayed on both the first and second display interface.

57. (original) The method according to claim 53, wherein the system simulates the deformation of a body cavity or lumen in response to movement of the medical device by the first user and displays the representation of the deformation on the first display interface.

58. (original) The method according to claim 53, wherein the medical device performs an operation on the simulated body cavity or lumen and the first display interface displays a simulation of the operation.

59. (original) The method according to claim 58, wherein the operation is inflation or deflation of a balloon within the simulated body cavity or lumen.

60. (original) The method according to claim 58, wherein the operation is injection of a radioopaque fluid within the body cavity or lumen.

61. (currently amended) The method according to claim 52, wherein the medical device is selected from the group consisting of a catheter, guidewire, endoscope, laparoscope, bronchoscope, stent, coil, balloon, a balloon-inflating device, a surgical tool, a vascular occlusion device, an optical probe, a drug delivery device, and combinations thereof.

62. (original) The method according to claim 54, wherein a first user inserts one or more additional medical devices into the simulated body cavity or lumen, and the movement of each medical device is independently monitored.

63. (currently amended) The method according to claim 52, wherein the simulated body cavity or lumen in the manikin further comprises a tactile feedback mechanism, providing continuous ~~vibrational~~ oscillatory feedback to a first user manipulating the medcial device to simulate medical device motion induced by simulated forces neing exerted on the medical device.

64. cancelled.
65. cancelled.
66. cancelled.
67. cancelled.
68. cancelled.
69. cancelled.
70. cancelled.
71. cancelled.
72. cancelled.
73. cancelled.

74. (currently amended) A system for simulating movement of a medical device in a body cavity or lumen of a patient, comprising:

(a) a medical device comprising a first end for manipulation by a user and a portion comprising a second end insertable into a simulated body cavity or body lumen in a manikin; ~~and~~

(b) a manikin comprising an interface for receiving the portion comprising the second end and for interfacing with a simulated body cavity or lumen within the manikin, wherein the interface comprises ~~a~~ an active feedback mechanism for providing continuous ~~vibrational~~ oscillatory feedback to the medical device;

(c) a computational engine for physically based modeling using finite element methodology, the computational engine simulating interactions between the medical device and body cavity or lumen; and

wherein the system models interactions between the medical device and the body cavity or lumen in three-dimensions, computes forces that would arise from interactions between the medical device and body cavity or lumen and feeds back said forces to the user.

75. (currently amended) A system for simulating movement of a medical device in a body cavity or lumen of a patient, comprising:

(a) a medical device comprising a first end for manipulation by a user and a portion comprising a second end insertable into a simulated body cavity or body lumen in a manikin;

(b) a manikin comprising an interface for receiving the portion comprising the second end and for interfacing with a simulated body cavity or lumen within the manikin; and

(c) a processor for simulating real-time movement of the medical device with a simulated body cavity or lumen, wherein deformation of the simulated body cavity or lumen in response to blood flow or the movement of the medical device

is modeled using physically based modeling that uses finite element methodology in real-time and wherein the processor computes forces that would arise from interactions between the medical device and body cavity or lumen and provides a feedback signal for simulating said forces.

76. (new) The system according to any of claims 1, 74, or 75, wherein one of the computational engine or the processor alters a finite element structure corresponding to the medical device and/or body cavity or lumen is altered in response to a manipulation of the medical device by the user.

77. (new) The system according to any of claims 1, 74, 75, wherein:

the simulated body lumen is a simulated blood vessel of a vascular system;

the system models interactions, using said one of the computational engine or the processor, between the medical device and a wall of the blood vessel and computes forces that would arise from the interactions between the device and the vessel wall and feeds back such computed forces back to the user.

78. (new) The system according to claim 77, wherein the one of the computational engine or the processor simulates a path that represents at least a portion of the vascular system and determines a fit between geomtery of the medical device and the geometry of the simulated path.

79. (new) The system of claim 77, wherein the blood vessel is modeled in the one of the computational engine or the processor as one of a rigid cylindrical body or a deformable strucutre to reflect a pathology of the blood vessel.

80. (new) The system of claim 77, wherein the system further includes modeling interactions between the medical device and flow of blood in the blood vessel.

81. (new) The method according to claim 52, further comprises the step of altering a finite element structure corresponding to the medical device and/or body cavity or lumen in response to a manipulation of the medical device by the user.

82. (new) The method of claim 52, wherein:

the simulated body luman is a blood vessel of a vascular system;

said performing physically based modeling includes performing physically based modeling to simulate interactions between the medical device and a wall of the blood vessel; and

said computing forces includes computing forces that arise from interactions between the medical device and the blood verssel.

83. (new) The method of claim 82, wherein said performing physically based modeling includes simulating a path that represents at least a portion of the vascular system and determining a fit between the geometry of the medical device and the geometry of the simulated path.

84. (new) The method of claim 82, wherein said performing physically based modeling includes performing physcially based modeling of the blood vessel as one of a rigid cylindrcial strcuture or a deformable strucutre to reflect a pathology of the blood vessel.

85. (new) The method of claim 82, further comprising:

modeling of interactions between the medical device and flow of blood in the blood vessel and provding a feed back of such interactions to the user.

86. (new) The system according to claim 1, wherein:

the simulated body lumen is a simulated blood vessel of a vascular system;

the computational engine embodying physically based modeling simulating interactions between the medical device and the simulated blood vessel; and

the system models interactions, using said computational engine, between the medical device and a wall of the blood vessel and computes forces that would arise from the interactions between the medical device and the vessel wall and feeds back such computed forces back to the user.

87. (new) The system according to claim 86, wherein the medical device is selected from the group consisting of a catheter, guidewire, endoscope, laparoscope, bronchoscope, stent, coil, balloon, a balloon-inflating device, a surgical tool, a vascular occlusion device, optical probe, a drug delivery device, and combinations thereof.

88. (new) The system according to claim 7 wherein the tactile feedback mechanism provides a continuous oscillatory feedback to a user holding the medical device to simulate medical device motion induced by simulated forces being exerted on the medical device by physiological paramters.

89. (new) The method according to claim 63 wherein the tactile feedback mechanism provides a continuous oscillatory feedback to a user holding the medical device to simulate medical device motion induced by simulated forces being exerted on the medical device by physiological paramters.